Tests conducted by two staff members of the Huron Portland Cement Company reveal the possibly harmful effect of carbon dioxide on fresh concrete.

Watch Those Unvented Heaters

WITH COLD-WEATHER concreting operations only weeks away, it is in order to remind this publication's readers of the possibly serious consequences of exposing fresh concrete to concentrations of carbon dioxide caused by heating devices which exhaust flue gases into closed rooms. This subject was thoroughly covered in a paper entitled "Effect of Carbon Dioxide on Fresh Concrete," written by J. A. Kauer and R. L. Freeman, respectively Technical Service Director and Technical Service Engineer of the Huron Portland Cement Company, and published in the December 1955 issue of the *Journal* of the American Concrete Insitute.

These authors point out that faulty floor surfaces of concrete placed during cold weather without the use of artificial heat can usually be traced to one or more of the following factors: the concrete was permitted to freeze; it was placed too wet; it dried too rapidly; it was improperly cured; it was over finished; or cement was dusted on to dry up the surface. They note, however, that from time to time floor surfaces go bad during winter construction when none of these factors is present. The source of trouble apparently lies elsewhere.

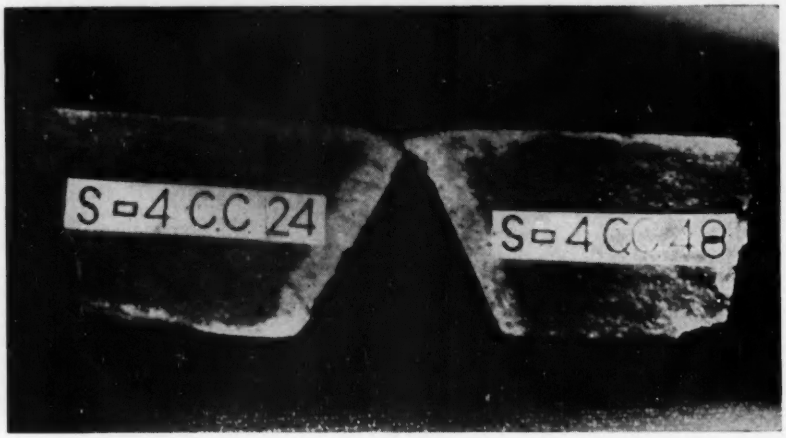
Several years ago they were called upon to investigate the cause of the soft surfaces of a warehouse floor being constructed in Wisconsin during winter weather. Construction methods were found to be all that could be desired, and the temperature in the structure was being maintained at about 50 degrees F. by means of oil burners. In the absence of any other evident cause, the contractor blamed the concrete and the cement. But the trouble persisted on subsequent placements with concrete purchased from a different ready-mix producer who used a different brand of cement. In each case, after five days of curing under wet burlap, the surface was found to be soft to a depth of about ⅛ of an inch.

The authors suggested that one section be placed and cured as before, but that another section be placed at the same time and cured with a membrane curing compound. Result: The membrane cured section was excellent, while the water-cured section showed the same soft surface characteristic of the earlier work.

As a further test, two sections of floor were then placed, finished and cured under identical conditions except that one was located in another building where permanently installed non-exhausting heating was available, while the other was located in the warehouse and protected from freezing by the temporary heaters. The warehouse section was again soft, while the floor protected by means of permanent heating was excellent and hard. This finding seemed to point rather squarely at the temporary heaters as being the cause of the poor surface concrete.

Subsequent field test work by the authors led them to conclude that of all the combustion gases that might be harmful to concrete, only carbon dioxide was present in sufficient concen-

Properly applied membrane curing agent protects fresh concrete against surface carbonation (light areas in photograph).



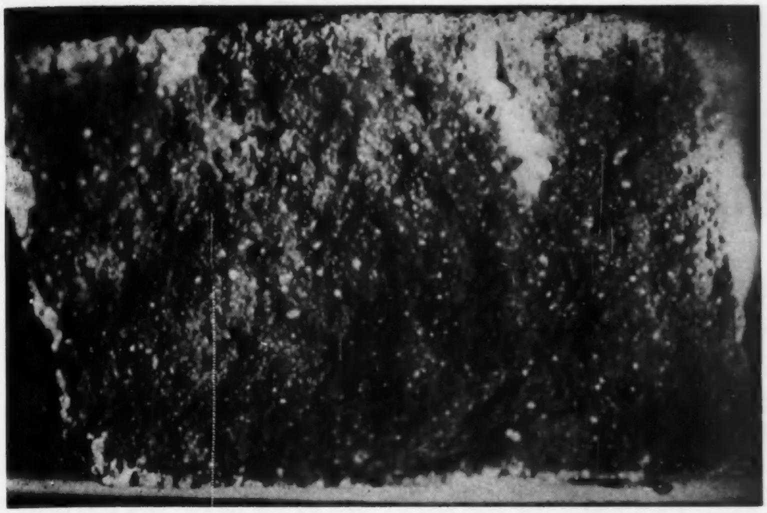
Inadequate membrane covering results in spotty and detrimental surface carbonation (light areas in photograph).

Depth of Carbonation in 24 Hours

Series No.	CO_2 percent, 24 hours	Temperature degrees F.	Relative humidity, percent	Depth of carbonation, inches			
				No CO_2	CO_2 atmosphere		
				Laboratory cured	Membrane cured	Burlap cured	Moist cured
1	16.8	40.6	97.4	0.011†	*	0.076	0.112
2	16.1	57.5	90.6	......	*	0.086	0.137
3	18.3	71.0	83.8	......	*	0.110	0.160
4	16.6	49.5	64.0	......	0.019	0.075	0.086
5	10.3	59.5	84.5	......	0.023	0.070	0.080
6	4.5	65.6	88.3	......	0.025	0.057	0.075

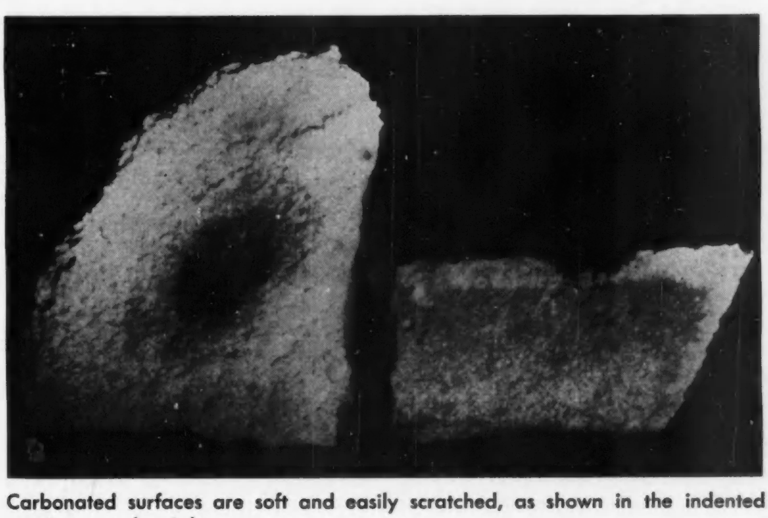
*Not included in Series 1, 2, and 3.

†One group of specimens only.



Carbon dioxide penetrates deeply wherever air bubbles or fissures are formed (light area to right of center).

Where no protection is afforded, a complete carbonation of the surface will result.



Carbonated surfaces are soft and easily scratched, as shown in the indented specimen at the right.

tration to have any measurable effect. They came to the conclusion that unvented heaters used during average cold weather construction could cause concentrations of carbon dioxide of approximately 5 per cent. This is equal to 143 times the amount found in the normal atmosphere.

These field observations were later confirmed in the laboratory. All specimens cured in a carbon dioxide atmosphere under laboratory control were found to be soft and easily scratched. The softness was present only through the carbonated portion, while the uncarbonated concrete was found to be hard and normal in all respects. The soft, chalk-like carbonated surface is formed by exposure to carbon dioxide during the first 24 hours after placing. After 24 hours the carbon dioxide atmosphere has no harmful effect at all, but on the contrary probably improves the quality of the concrete.

It was found that if the concrete is completely sealed off or protected for the first 24 hours by means of a membrane curing compound or similar surface sealer, no damage results from carbonation.

The authors of the *Journal* paper advance the theory that if carbonation due to CO_2 takes place when the cement gel is in an unstable condition, the results will be detrimental to the surface hardness of the concrete, but that both hardness and strength may actually be increased if carbonation takes place after the cement gel is in stable state.

They conclude their excellent paper with these suggestions on how to prevent carbonation damage to floors placed during cold weather:

a) Use temporary heaters which do not allow combustion gases to contaminate the air.

b) Use a membrane curing agent if unvented heaters must be used. Be sure the surface is completely sealed. Burlap or wet cure is apparently not sufficient protection.

c) If salamanders or unvented heaters are used, provide proper stacking to exhaust combustion gases to the outside.

The authors also recommend that additional research be undertaken to confirm or refute the conclusions drawn from their limited studies. In view of their findings, however, and because of the increasing demand for winter construction, concrete men will surely want to adopt the simple precautionary measures noted above. END

It isn't just luck . . .

When a Concrete Contractor Makes Money

CONCRETE CONTRACTORS who run a profitable business operate according to certain principles. They observe practices that promise a good return on their efforts and investment. Just talk to one who is making good. See if his success story doesn't pretty much follow this formula:

He knows his business. He recognizes his own limits in manpower and equipment and doesn't bid on jobs he can't handle. At the same time, he tries to measure his potential for growth. A job may come along that requires an investment in additional equipment. Buying that new equipment can put him in a position to take on a new variety of jobs. If such jobs are frequently available in his area, he considers that it may be time to expand.

Another thing he weighs is whether he wants to be jack-of-all-trades or specialize. The key to this choice is in the opportunities presented by the area. He investigates his market . . . finds out what the needs and demands are. Then he gears himself to fill these and herein finds his reason for being—and for succeeding—as a contractor.

He reads appropriate business publications as one way of keeping up with market trends. And he attends local concrete contractor meetings to pick up news of the trade. He talks to builders and real estate men in the area.

Another good source of trade information, he knows, is the Government Printing Office. The government is continuously turning out pamphlets and booklets on new developments in industry, wage trends, labor conditions, etc. He's probably on their mailing list for free periodic listings of all the latest government publications—by writing the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

He works efficiently. He always does a careful cost estimate before bidding on a job. He takes time to go out to the job site and look around at the conditions and problems. He even tries to figure the weather conditions. Once the job is his, he looks for ways to speed up production and tries to figure out cost-cutting techniques. Every assignment is different. Each situation presents a challenge to try something new instead of proceeding in the same old habitual ways. Being alert to the challenge of each new job can mean a saving of time and money.

No job is too small. A successful contractor is never snooty. When a small home owner comes around and asks him to lay a floor for his breezeway or put a swimming pool in the backyard, he accepts cheerfully. A small job competently handled can mean leads to new and bigger jobs. There is no advertising so effective as a word-of-mouth recommendation.

Besides, he realizes that even though life looks rosy now, leaner times may come when he'll have to go out and scratch for jobs. That's when good will and courteous treatment of customers can mean a man's livelihood. The small home owner who remembers such treatment may be just the fellow who will be able to help him out when the going's rough.

Customer good will pays off. He builds business by earning the respect and confidence of his customers. This means backing up his words and promises with deeds. A commitment to appear on a particular day to do a job means he'll be there! He treats his customer's money with respect, too. If payment is on an hourly basis, it works greatly in his favor to do the job in half the time that his competitors predicted it would take.

He's within easy reach. When he's spending a day out at the job site, he keeps in touch with his office. Calls are made frequently so that he can act fast on any good bids or customer queries that have come in. Some have found it a worth-while investment to install a telephone in the car or pick-up truck for this purpose.

He's specific. Especially about prices, maximum and minimum. Even if he has to shoot for the minimum, the customer will rely on his word as final and a minimum profit is still assured. A hazy approach to prices can lead to misunderstanding, bad feelings, and a loss of profits.

He asks for the job. He isn't too shy to ask for the order. Many a contractor has lost the job after a bid simply because he failed to follow up with a direct inquiry. Even without a bid, there are lots of jobs around that can be had practically for the asking.

How are YOU doing? Are you following this simple formula for winning and keeping customers through the quality of your performance? There's a lot of talk about competition these days, but you don't have to waste your time worrying about it if you're confident that you are offering your best in service to customers—and doing your best to keep up with the needs of your trade.

The building business has a lot of catching up to do to replace outmoded homes, to supply new ones for a growing population, to provide more schools, to supply new roads to a nation on wheels. There's no end in sight to the work that has to be done to keep up with current demands. It's a time when a concrete contractor with sound business methods *makes money.* END

Concrete contractors can fight rising costs by tying many types of forms with ordinary steel strapping

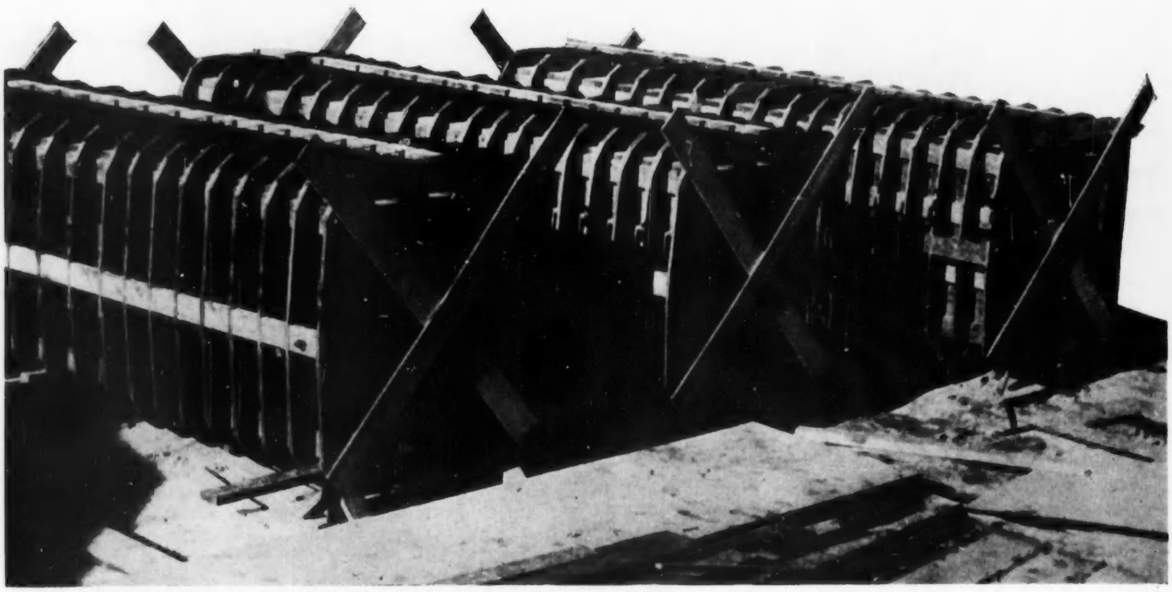
Demonstrating new form tying method involving use of steel strapping.

A. N. PERRY
Manager of Sales Engineering Dept.
Signode Steel Strapping Company

New Form Tying Method

NEVER BEFORE in the history of concrete construction has there been such a general demand for new job methods to combat the steady rise in labor and material costs. Among the promising developments helping to meet this need are new form tying methods involving the use of the same steel strapping material which has revolutionized the whole science of packaging and carloading.

Typical applications of steel strapping in the field of concrete construction include forming low walls for



Close-up of bridge pier forms showing steel strapping.

houses, form tying of heavy industrial foundations, fireproofing horizontal beams, and forming columns and piers for almost any type of construction. Using either the standard tension tools developed for packaging applications, or the special tools which a few manufacturers have designed for the concrete field, form tying with steel strapping can result in savings in both labor and materials. It makes it possible to build forms on the job more quickly and with less material. Properly strapped forms also reduce the likelihood of hazardous failures, as well as minor form distortion which may necessitate costly extra hours of work by finishers.

Most manufacturers of steel strapping have developed their own spacing formulas and truss designs. Trusses for column work are designed to eliminate spreading, corner leakage, and bowing in the middle of the panels, and the patterns are flexible enough to be used with plywood or any other type of wooden panel.

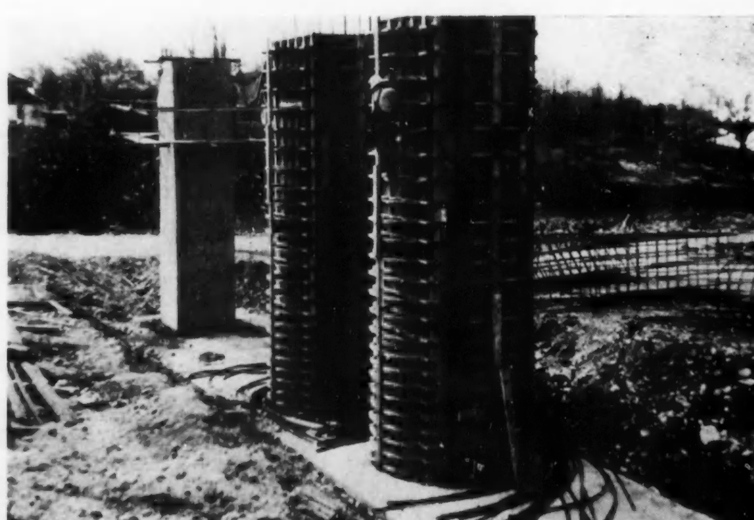
Once a column form is trussed, under normal conditions it can be strapped by one man in about 15 minutes. The strapping is usually applied with the forms resting on horses.

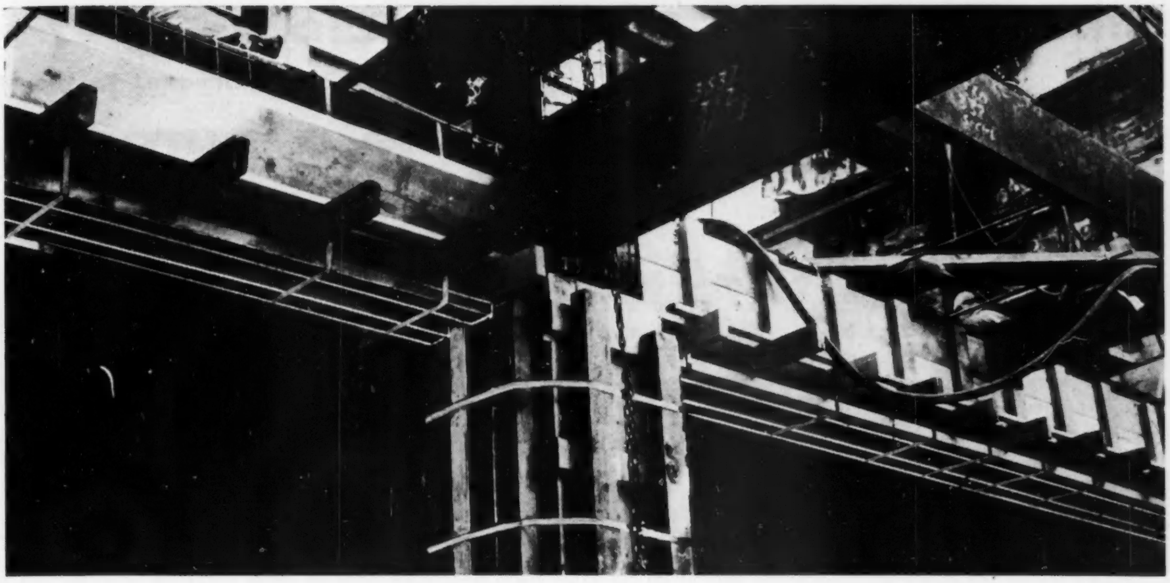
The use of strapping speeds up the stripping of forms, since the panels can be removed instantly by simply cutting the straps. Since strapped forms hold together well even under extremes of static head and stresses resulting from vibration, corner leakage is not a problem.

There are similar advantages in

Left: Assembling properly strapped bridge pier forms on ground.

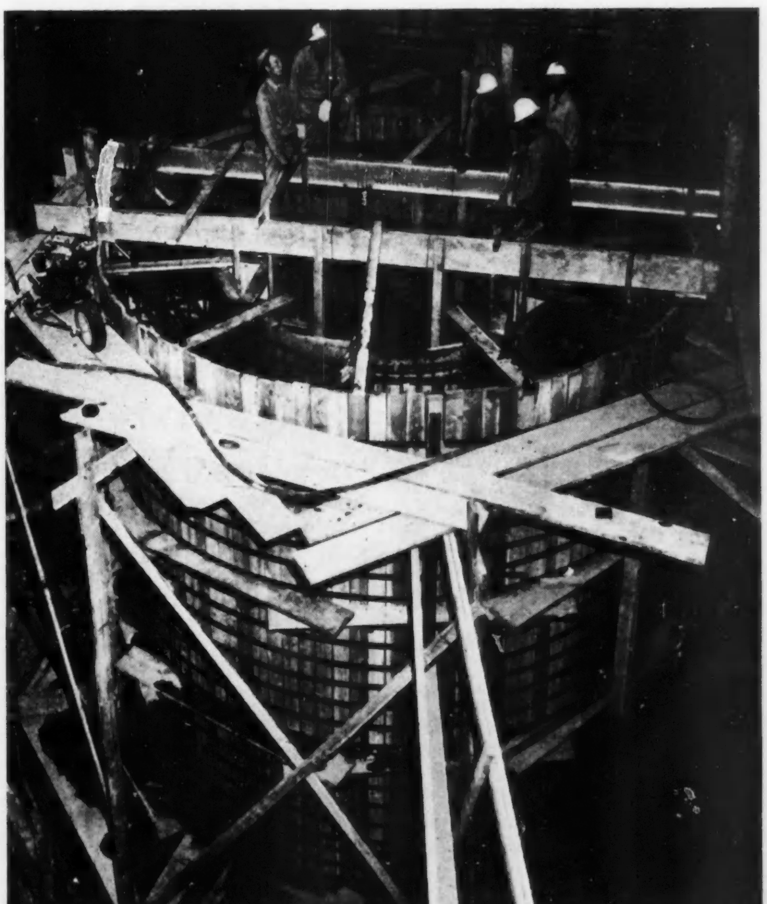
Right: Stripping the steel strapping from bridge piers.





Above: Use of steel strapping for encasing steel beams in concrete, which prevents buckling in case of fire.

Below: Giant casting hub for copper refinery, ready for pouring, is tied with over 20 bands of steel strapping.



using strapping for fireproofing steel beams with concrete. One of the important features of this application is the elimination of shoring jacks, thus leaving floor areas beneath beams clear for other work. In the stripping operation the straps are left in the concrete and broken off at the surface. On one project, a YMCA building in Milwaukee, whole floors were poured while supported by strapping hung from steel beams. The contractor, Gebhard & Berghammer, believes that the work was done faster and at less cost than would have been possible by other methods.

A quite recent application of steel strapping in the concrete construction field is in the tying of foundation wall forms for dwellings. Strapping is cut to length according to a predetermined spacing and laid on the foot of the wall. The forms are placed in position and wooden spacers are set between the inside and outside panels. The straps are joined and tensioned, and then the wall is poured. When the concrete has set, the straps are cut. Left-over strapping inside the wall is snapped off flush with the wall surface, while the strapping on the ouside of the wall is left to be covered in grading.

The accompanying job-site photographs show just a few examples of the use of steel strapping for tying concrete forms. With new information on the subject being developed at a rapid rate, both in the laboratory and the field, steel strapping techniques are bound to become an important cost-saving method for alert concrete builders. END

state licensing for contractors—

has it become a parade?

A TOTAL OF 18 STATES now require some sort of licensing for contractors doing business within their borders, notes *Engineering News-Record.* Newest member of this group is Louisiana where licenses are required for contractors bidding on jobs in excess of $30,000.

With some state contractor licensing laws now more than 30 years old, the subject has long been a matter of serious controversy within the construction industry — with proponents generally contending that the laws enforce responsibility on the construction industry, and opponents arguing that the tendency is to make closed corporations out of specific areas.

A survey by the magazine in the other 17 states where such laws are in effect produced about equally divided sentiments among construction industry representatives, many objecting particularly to provisions requiring submission of financial statements to examining boards made up of competitive contractors; those in favor citing easier control of shoddy operators.

As enacted, Louisiana's new law reestablishes a board that was abolished in 1950. Seven board members —each of whom must have had at least ten years of contracting experience—will administer the law. Specifically exempted are private residential builders; architects and civil engineers; contractors bidding on federal-aid work (who must obtain licenses, however, before starting work); and public utilities.

Contractor licensing laws (other than those controlling specialty trades such as plumbers and electricians) have been on state books for at least 30 years, since Utah passed its control law in 1926. One state—Florida—requires licensing, but the law is aimed at all business and applies equally to shoe stores, soda fountains and contractors, who may be required to have licenses both from the state and from a city or county.

With a few exceptions, the laws have some similarities:

All but three (Delaware, Montana, North Dakota) have special licensing boards to administer the law—all of which are composed of men with required contracting experience. Five of the states do not require a financial statement as a prerequisite for licensing; 12 require such statements. All states set monetary limits on the type of work for which a license is required of the contractor. The range of these limits extends from $100 and up (California) to $200,000 or more (Virginia). All states provide monetary penalties for failure to comply with the laws, and all provide machinery for hearings, investigation and prosecution of violators. One state—Michigan—aims its law specifically and entirely at home builders, requiring licenses for residential contruction in counties with populations of 300,000 or more, or where voted upon by county authorities. Most states exempt public works that involve federal money from licensing provisions.

Reaction to the laws and their administration is as varied as the states in which the statutes are effective, the magazine says. In Arizona and California—two of the states with the oldest laws (1930 and 1929 respectively)—support both from contractors and labor unions is on the enthusiastic side in a majority of instances. Other generally unqualified votes of confidence come from Michigan, North Carolina, North Dakota, Tennessee and Utah.

Qualified approval comes from other states. In Montana, contractors feel that the law is too much of a revenue-producing act and not regulatory enough; and in South Carolina, state officials are awaiting the reaction to an amendment requiring licensing for mechanical contractors.

Opposition is apparent in New Mexico, where contractors are complaining that the law as passed (1939) still enforces an obsolete building code; that enforcement is lax, particularly in rural areas, and that political pressures have been evident. In Mississippi, though large contractors generally are said to favor the licensing, small ones have opposed it bitterly on the basis of the requirement that they submit financial statements and that too much is excluded from coverage. **END**

here's how the states compare:

Arizona: License required of all contractors.

Arkansas: License required for projects of $20,000 or more.

California: License required for general and subcontractors on work of $100 or more.

Delaware: All contractors must have licenses.

Florida: Occupational license required.

Idaho: License required for bidding on public works.

Michigan: On residential building only, in counties of 300,000 or more.

Mississippi: License for projects totaling more than $3,000 at any one time.

Montana: License required for all public work.

Nevada: License for all contractors.

New Mexico: License for all contractors.

North Carolina: License for work over $20,000.

North Dakota: License for public work over $2,000.

South Carolina: License for all work $12,500 or over.

Tennessee: License for work over $10,000.

Utah: License for work over $200.

Virginia: License for work over $200,000.

Bureau of Standards tests show many small reinforcing bars provide best means of controlling width of cracks in concrete beams.

Control of Cracks in Reinforced Concrete

DETAILED INFORMATION on the cracking of loaded concrete beams and slabs is now available as a result of recent investigations at the National Bureau of Standards. The investigations were carried out in the NBS structural engineering laboratories by A. P. Clark of the American Iron and Steel Institute's Research Fellowship at the Bureau.

The test results promise to prove useful in controlling the spacing and width of cracks in the future design of reinforced concrete structures. In general, *the results show that width of cracks can best be controlled by using a large number of small reinforcing bars and by increasing the reinforcement.*

Formation of tensile cracks in reinforced concrete flexural members containing conventional, non-prestressed reinforcement is usually unavoidable since concrete has a low extensibility. While cracks barely wide enough to be visible may be objectionable only because of appearance, cracks of greater width can be dangerous because of the possibility of corrosive agents attacking the steel reinforcing bars. Excessively wide cracks can also result in leakage in such structures as dams, tanks, and pools. The Bureau findings —*that is, by increasing the bond strength between concrete and steel with improved reinforcing bars, widths of cracks may be reduced*—will therefore make a significant improvement in reinforced concrete structures.

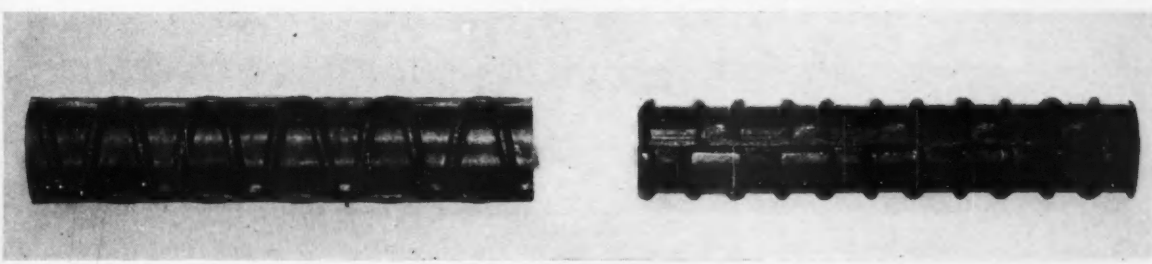
During the past ten years, the reinforcing bar industry has developed such an improved type of reinforcing bar. Investigations have already shown that the improved bars, when used with axially loaded cylindrical specimens, reduce crack width 20 to 40 per cent as compared with older bar designs. However, the NBS tests were the first systematic tests to use beam and slab specimens with the new bars. For the first time, they provide data on beam specimens containing this improved type of reinforcing bars, and this data is significant in the control of cracks.

How Tests Were Made

The study of crack formation at NBS included tests on 58 beams and slab specimens. The beams were of two sizes: (1) 6-inch by 15-inch by 11-foot, tested on a 9-foot span; and (2) 6-inch by 23-inch by 13-foot, tested on an 11-foot span. The slabs measured 6 inches deep, 8 feet long, were from 6 inches to 15 inches wide, and were tested on a 6-foot span. All specimens were tested as simply supported beams with loads applied at quarter points.

The specimens were cast in steel molds, and all were from the same type of concrete mixture. The tensile reinforcement — deformed bars of a commercially available design — was placed near the bottom of the mold. Three standard 6- by 12-inch cylinders were cast with each specimen to determine the compressive strength of the concrete. These cylinders were cured and stored in the same manner as the specimens, and were tested at the same age.

Samples of improved reinforcing bar used in the investigation at NBS.



The tests were performed in a 600,000-pound-capacity hydraulic machine. The load was applied in increments which ranged from 500 to 5000 pounds, and the loading proceeded until the specimen failed by yielding of the reinforcement. Location and extent of cracks were recorded immediately following application of each increment of load.

For individual beam specimens, the ratio of maximum width of crack to the average width ranged from 1.18 to 2.77. However, the average maximum width of crack was about 1.64 times the average width for each value of stress considered, where the computed steel stresses ranged from 15,000 to 40,000 psi.

Where the computed stress in the steel was 20,000 psi, crack width ranged from 0.001 to 0.005 of an inch.

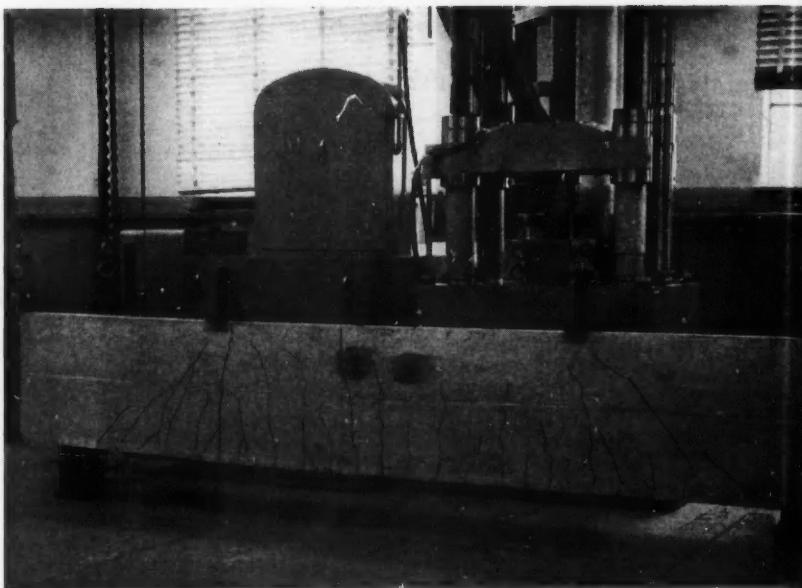
Where the computed stress was 30,000 psi, the values ranged from 0.002 to 0.007 of an inch.

Where the computed stress was 40,000 psi, the values ranged from 0.004 to 0.010 of an inch.

The average spacing of cracks decreased rapidly with an increase in steel stress beyond that causing the first crack, and at a stress of 30,000 psi or more the average spacing appeared to approach a constant value. For individual specimens, the minimum average crack spacing varied from approximately 3 to nearly 7 inches, with a 4-inch average spacing for all the specimens.

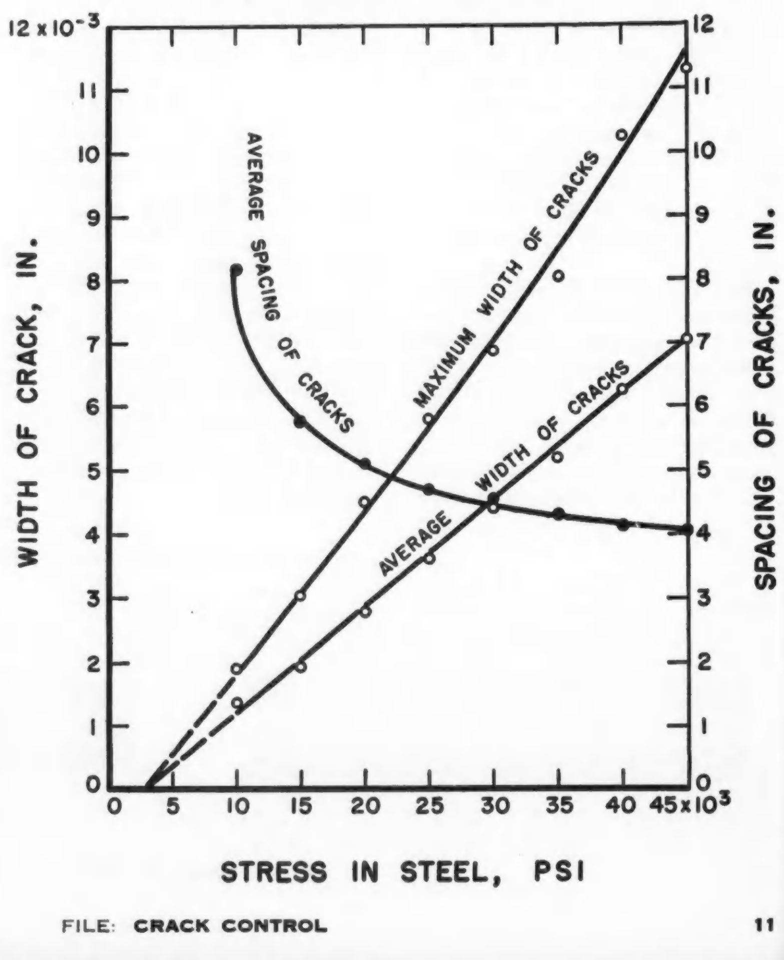
Since concrete is a mixture of several materials and cracks occur at random, the location and spacing of cracks vary considerably. While the results showed this expected scatter, the average width of cracks was found to be in proportion to the increase in steel stress beyond that causing the initial cracking. The average width is also in proportion to the product of two parameters D/p and (h-d)/d, where D is the diameter of the bar, p is the ratio of reinforcement, and h and d are respectively the over-all and effective depth of the beam.

These findings are in general agreement with those of other investigators who reported that the width of cracks can be reduced by using a large number of small bars and by increasing the ratio of reinforcement. Since they were systematically controlled under laboratory conditions, they are recommended to all contractors concerned about the control of cracks in reinforced concrete. END



Here is one of the 58 specimens tested in the NBS investigations. It shows the formation of cracks produced by loading the reinforced beam in a 600,000-lb. hydraulic testing machine.

Range of Spacing and Widths of Cracks for Various Steel Stress



when are construction workers under Fair Labor Standards Act?

A NEW INTERPRETIVE bulletin on coverage of the Fair Labor Standards Act in the construction industry states the guiding principles to be followed by the Administrator in determining when workers engaged on construction projects are covered by the law. The act requires payment of $1 per hour minimum wages and payment of time and a half for work over 40 hours per week to employees "engaged in commerce or in the production of goods for commerce." Some excerpts from the bulletin:

Covered Projects: "All employees who are employed in connection with construction work which is closely or intimately related to the functioning of existing instrumentalities and channels of interstate commerce or facilities for the production of goods for such commerce are within the scope of the Act. Closely or intimately related construction work includes the maintenance, repair, reconstruction, redesigning, improvement, replacement, enlargement or extension of a covered facility. If the construction project is subject to the Act, all employees who participate in the integrated effort are covered. . . .

"*On non-covered construction projects.* A construction project may be purely local and, therefore, not covered, but some individual employees may nonetheless be covered on independent ground by reason of their interstate activities. Under the principle that coverage depends upon the particular activities of the employee and not on the nature of the business of the employer, individual employees engaged in interstate activities are covered even though their activities may be performed in connection with a non-covered construction project. Thus, the Act is applicable to employees who are regularly engaged in ordering or procuring materials and equipment from outside the state or receiving, unloading, checking, watching or guarding such goods while they are still in transit. . . ."

Types of Construction: The relationship of the construction work to the production of goods for commerce or to facilities of commerce is the main factor on whether the wage-hour law applies. The nature of this relationship is stated in the following excerpt from the bulletin:

"*Relationship of the construction work to the covered facilitiy.* Unless the construction work is physically or functionally integrated or closely identified with an existing covered facility it is not regarded as covered construction because it is not closely enough related to or integrated with the production of goods for commerce or the engagement in commerce. For this reason the erection, maintenance or repair of dwellings, apartments, hotels, churches and schools are not covered projects. Similarly the construction of a separate, wholly new, factory building, not constructed as an integral part or as an improvement of an existing covered production plant, is not covered. Coverage of any construction work, whether new or repair work, depends upon how closely integrated it is with, and how essential it is to the functioning of, existing covered facilities. Neither the mere fact that the construction is 'new construction' nor the fact that it is physically separated from an existing covered plant, is determinative. . . .

"The repair or maintenance of a covered production unit is essential for its continued operation and has a close and immediate tie with the production of goods for commerce. The Act is also applicable to other construction which is an integral part of a covered production unit, such as the replacement, enlargement, reconstruction, extension or other improvement of the premises, the buildings, the machinery, tools and dies and other equipment. Functionally such work is like maintenance and repair and is necessary for the continued, efficient and effective operation of the facility as a unit. . . ."

New Factory Construction: "Construction of a new factory building, even though its use for interstate production upon completion may be contemplated, will not ordinarily be considered covered. However, if the new building is designed as a replacement of or an addition or an improvement to, an existing interstate production facility, its construction will be considered subject to the Act.

"If the new building, though not physically attached to an existing plant which produces goods for commerce, is designed to be an integral part of the improved, expanded or enlarged plant, the construction, like maintenance and repair, would be subject to the Act."

Preparatory to Production: "Coverage extends to employees engaged in the installation of machinery to be used in covered production in a new factory building, even though the construction of the building itself may not have been subject to the Act. Such installation is considered to be a preliminary production activity rather than simply part of the construction of the building.

"If the construction project is subject to the Act, preliminary activities, such as surveying, clearing, draining and leveling the land, erecting necessary buildings to house materials and equipment, or the demolition of structures in order to begin building the covered facility, are subject to the Act." END